

WHAT IS CLAIMED IS:

1. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, comprising the steps of:

5                   forming a porous film composed of a polymer material; and

                  modifying at least a portion of said porous film by bonding a predetermined substituent different from the group contained in said polymer  
10                   material to the carbon atoms of the backbone chain of said polymer material through at least two successive carbon atoms in said predetermined substituent.

2. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim  
15                   1,

                  wherein said modification step is for causing a modifier having one to 100 parts by mass of said predetermined substituent to react with 100 parts by mass of said polymer material constituting said porous  
20                   film.

3. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim  
1,                   

                  wherein said porous film forming step is  
25                   for forming a porous film using a mixture material of said polymer material and said modifier having said predetermined substituent.

4. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim  
30                   1,

                  wherein said modification step includes the step of coating said modifier having said predetermined substituent on the surface of said porous film, and

35                   wherein a selected one of said predetermined substituent of said modifier and said backbone chain is bonded to said predetermined

substituent after said coating step.

5. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 1,

5 wherein said modification step includes the step of radiating a high-energy beam on said porous film thereby to bond a selected one of said predetermined substituent and said backbone chain to said predetermined substituent.

10 6. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 1,

15 wherein said modification step includes the step of coating an initiator for starting the linkage between selected one of said predetermined substituent and said backbone chain and said predetermined substituent by heating said porous film, and the step of heating said porous film.

20 7. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to any one of claims 2 to 6,

wherein said modifier contains at least one compound having at least one polymerization group.

25 8. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 7,

wherein said polymerization group is an unsaturated multiple bond.

30 9. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to any one of claims 2 to 6,

35 wherein said modifier is at least selected one of monoallyl isocyanurate, diallyl isocyanurate, triallyl isocyanurate, triallyl cyanurate, ethylene glycol di-{meth} acrylate, trimethyl propantri {meth}-acrylate, diallyl phthalate, divinyl benzene, vinyl toluene, vinyl pyridine, triallyl phthalate, vinyl

trichlorosilane, vinyl tris ( $\beta$ -methoxy ethoxy) silane, vinyl triethoxy silane, vinyl trimethoxy silane,  $\gamma$ -({meth}-acryloxy propyl) trimethoxy silane,  $\gamma$ -({meth} acryloxy propyl) triethoxy silane,  $\gamma$ -({meth}-acryloxy propyl) methyl dimethoxy silane and acryl silicone.

10. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 1,

wherein said polymer material is at least one of polybenzimidazole, polyimide, polyether imide, polyamide imide, polyphenylene sulfide, polyether sulfone, polysulfone, polyether ether ketone, polymethyl pentene, aramide, polyvinylidene fluoride, polyamide, polyethylene telephthalate, polybutylene telephthalate, polyethylene naphthalate, polybutylene naphthalate, polyarylate, polyacetal and polyphenylene ether.

11. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 7,

wherein said modifier is a compound having a LUMO energy value of not less than 0.3 eV with the polymerization group open.

12. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 11,

wherein said modifier includes at least one of ethylene glycol dimethacrylate, trimethylol propane trimethacrylate, cyclohexyl methacrylate, octafluoro pentyl acrylate, octafluoro pentyl methacrylate, tetrafluoro propyl acrylate, tetrafluoro propyl methacrylate, vinyltris ( $\beta$ -methoxy ethoxy) silane, vinyl triethoxy silane, vinyltrimethoxy silane,  $\gamma$ -(acryloxy propyl) trimethoxy silane,  $\gamma$ -(methacryloxy propyl) trimethoxy silane,  $\gamma$ -(acryloxy propyl) triethoxy silane, and  $\gamma$ -(methacryloxy propyl) triethoxy silane.

13. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 7,

5 wherein said modifier is a compound having a HOMO energy value of not more than -10.1 eV with the polymerization group open.

14. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 13,

10 wherein said modifier includes at least one of ethylene glycol dimethacrylate, trimethylol propane trimethacrylate, cyclohexyl methacrylate, octafluoro pentyl acrylate, octafluoro pentyl methacrylate, tetrafluoro propyl acrylate, tetrafluoro  
15 propyl methacrylate, heptadecafluoro decylacrylate, heptadecafluoro decylmethacrylate, vinyltris ( $\beta$ -methoxy ethoxy) silane, vinyl triethoxy silane, vinyltrimethoxy silane,  $\gamma$ -(acryloxy propyl) trimethoxy silane, and  $\gamma$ -(acryloxy propyl) triethoxy silane.

20 15. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 1,

wherein said predetermined substituent has a -SiOSi- structure.

25 16. A method of fabricating a porous film of a non-aqueous electrolyte secondary battery, according to claim 1, further comprising the step of bonding said predetermined substituent to a second modifier having a -SiOSi- structure.

30 17. A method of fabricating the electrode of a non-aqueous electrolyte secondary battery, comprising the steps of:

forming an electrode plate providing a positive electrode or a negative electrode of said non-aqueous electrolyte secondary battery; and  
35 attaching a porous film constituted of a

polymer material on the surface of said electrode plate by forming said porous film on said surface of said electrode plate thereby to produce said electrode with a porous film formed thereon;

5                    wherein said porous film attaching step includes the step of modifying at least a portion of said porous film by bonding a predetermined substituent different from the group contained in said polymer material to the carbon atoms of the backbone chain of  
10                   said polymer material through at least two successive carbon atoms in said predetermined substituent after said porous film forming step.

18. A method of fabricating the electrodes of a non-aqueous electrolyte secondary battery, according to  
15                   claim 17,

                  wherein said porous film forming step is for forming a porous film on the surface of said electrode plate by coating said polymer material in liquid state on the surface of said electrode plate.

20                   19. A method of fabricating the electrodes of a non-aqueous electrolyte secondary battery, according to claim 17,

                  wherein said porous film forming step is for forming a porous film separate from said electrode  
25                   plate, and

                  wherein said porous film attaching step includes the step of securely fixing said porous film on the surface of said electrode plate after said porous film forming step.

30                   20. A porous film composed of a polymer material for a non-aqueous electrolyte secondary battery,

                  wherein at least a portion of said polymer material is modified by a predetermined substituent different from the group contained in said polymer  
35                   material, said predetermined substituent having at least two successive carbon atoms bonded to the carbon atoms of the backbone chain of said polymer material.

21. A porous film of a non-aqueous electrolyte secondary battery, according to claim 20,

5. wherein a protective layer induced from the modifier having a LUMO energy value of not less than 0.3 eV is formed on the surface of said porous film with the polymerization group open.

22. A porous film of a non-aqueous electrolyte secondary battery, according to claim 21,

10. wherein said polymerization group is an unsaturated multiple bond.

23. A porous film of a non-aqueous electrolyte secondary battery, according to claim 21,

15. wherein said modifier includes at least one of ethylene glycol dimethacrylate, trimethyrol propane trimethacrylate, cyclohexyl methacrylate, octafluoro pentyl acrylate, octafluoro pentyl methacrylate, tetrafluoro propyl acrylate, tetrafluoro propyl methacrylate, vinyltris ( $\beta$ -methoxy ethoxy) silane, vinyl triethoxy silane, vinyltrimethoxy silane,  $\gamma$ -  
20. (acryloxy propyl) trimethoxy silane,  $\gamma$ -(methacryloxy propyl) trimethoxy silane,  $\gamma$ -(acryloxy propyl) triethoxy silane, and  $\gamma$ -(methacryloxy propyl) triethoxy silane

24. A porous film of a non-aqueous electrolyte secondary battery, according to claim 20,

25. wherein a protective layer induced from the modifier having a HOMO energy value of not more than -10.1 eV is formed on the surface of said porous film with the polymerization group open.

30. 25. A porous film of a non-aqueous electrolyte secondary battery, according to claim 24,

wherein said polymerization group is an unsaturated multiple bond.

26. A porous film of a non-aqueous electrolyte secondary battery, according to claim 24,

35. wherein said modifier includes at least

one of ethylene glycol dimethacrylate, trimethyrol  
propane trimethacrylate, cyclohexyl methacrylate,  
octafluoro pentyl acrylate, octafluoro pentyl  
methacrylate, tetrafluoro propyl acrylate, tetrafluoro  
5 propyl methacrylate, heptadecafluoro decylacrylate,  
heptadecafluoro decylmethacrylate, vinyltris ( $\beta$ -methoxy  
ethoxy) silane, vinyl triethoxy silane, vinyltrimethoxy  
silane,  $\gamma$ -(acryloxy propyl) trimethoxy silane, and  $\gamma$ -  
(acryloxy propyl) triethoxy silane.

10 27. A porous film of a non-aqueous electrolyte  
secondary battery, according to claim 20,  
wherein said predetermined substituent has  
a -SiOSi- structure.

15 28. A porous film of a non-aqueous electrolyte  
secondary battery, according to claim 20,  
wherein said predetermined substituent is  
bonded to a second modifier having a -SiOSi- structure.

20 29. An electrode of a non-aqueous electrolyte  
secondary battery, comprising:  
an electrode plate providing a positive  
electrode or a negative electrode for the non-aqueous  
electrolyte secondary battery; and

25 a porous film configured of a polymer  
material and integrally formed on said electrode plate  
with at least selected one of the backbone chain of said  
polymer material modified by a predetermined substituent  
different from the group contained in said polymer  
material.

30 30. A non-aqueous electrolyte secondary battery,  
comprising an electrode unit including a positive  
electrode and a negative electrode stacked one on the  
other through a separator,

35 wherein said separator is selected one of  
the porous film fabricated by the method of fabricating a  
porous film of non-aqueous electrolyte secondary battery  
according to any one of claims 1 to 16 and the porous

31. A non-aqueous electrolyte secondary battery, comprising an electrode unit including a positive electrode and a negative electrode stacked one on the other,

wherein selected one of said positive electrode and said negative electrode is selected one of the electrode fabricated by the method of fabricating a non-aqueous electrolyte secondary battery according to any one of claims 17 to 19 and the electrode of a non-aqueous electrolyte secondary battery according to claim 29.